of conducting the affairs and guarding the interests of the State." Would that all ministers would realise and act upon the great truth, so clearly and pithily expressed. Mr. Ellery contributes monthly a very valuable and interesting set of "Astronomical Notes," in which he gives all the details in a tabular form necessary to find out the positions, on the first of each month, of the planets, nebulæ, clusters, and double and other peculiar stars. We hope the journal will have all the success it well deserves.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Jan. 30.—Prof. George Busk, vice-president, in the chair. The following communications were read:—"Note on the Origin of *Bacteria*, and on their Relation to the Process of Putrefaction." By Dr. H. Charlton Bastian, F.R.S.

In his now celebrated memoir of 1862, M. Pasteur asserted and claimed to have proved (1) that the putrefaction occurring in certain previously boiled fluids after exposure to the air was due to the contamination of the fluids by *Bacteria*, or their germs, which had before existed in the atmosphere; and (2) that all the organisms found in such fluids have been derived more or less immediately from the reproduction of germs which formerly existed in the atmosphere.

The results of a long series of experiments have convinced me that both these views are untenable.

In the first place, it can be easily shown that living *Bacteria*, or their germs, exist very sparingly in the atmosphere, and that solutions capable of putrefying are not commonly infected from this source.

It has now been very definitely ascertained that certain fluids exist which, after they have been boiled, are incapable of giving birth to *Bacteria*, although they continue to be quite suitable for the support and active multiplication of any such organisms as may have been purposely added to them. Amongst such fluids I may name that now commonly known as "Pasteur's solution," and also one which I have myself more commonly used, consisting of a simple aqueous solution of neutral ammonic tartrate and neutral sodic sulphate.* When portions of either of these fluids are boiled and poured into superheated flasks, they will continue quite clear for many days, or even for weeks—that is to say, although the short and rather narrow neck of the flask remains open the fluids will not become turbid, and no *Bacteria* are to be discovered when they are submitted to microscopical examination.

But in order to show that such fluids are still thoroughly favourable media for the multiplication of *Bacteria*, all that is necessary is to bring either of them into contact with a glass rod previously dipped into a fluid containing such organisms. In about thirty-six hours after this has been done (the temperature being about 80° F.), the fluid, which had hitherto remained clear, becomes quite turbid, and is found, on examination with the microscope, to be swarming with *Bacteria*.†

Facts of the same kind have also been shown by Dr. Burdon Sanderson‡ to hold good for portions of boiled "Pasteur's solution." Air was even drawn through such a fluid daily for a time, and yet it continued free from *Bacteria*.

Evidence of this kind has already been widely accepted as justifying the conclusion that living *Bacteria* or their germs are either wholly absent from, or, at most, only very sparingly distributed through the atmosphere. The danger of infection from the atmosphere having thus been got rid of and shown to be delusive, I am now able to bring forward other evidence tending to show that the first *Bacteria* which appear in many boiled infusions (when they subsequently undergo putrefactive changes) are evolved *de novo* in the fluids themselves. These experiments are moreover so simple, and may be so easily repeated, that the evidence which they are capable of supplying lies within the reach of all.

That boiling the experimental fluid destroys the life of any *Bacteria* or *Bacteria* germs pre-existing therein is now almost universally admitted. It may moreover be easily demonstrated. If a portion of "Pasteur's solution" be purposely infected with boiled *Bacteria* and subsequently boiled for two or three minutes, it will continue (if left in the same flask) clear for an indefinite period; whilst a similarly infected portion of the same fluid, not subsequently boiled, will rapidly become turbid. Precisely similar phenomena occur when we operate with the neutral fluid which I have previously mentioned; and yet M. Pasteur has ventured to assert that the germs of *Bacteria* are not destroyed in neutral or slightly alkaline fluids which have been merely raised to the boiling-point.*

Even M. Pasteur, however, admits that the germs of *Bacteria* and other allied organisms are killed in slightly acid fluids which have been boiled for a few minutes; so that there is a perfect unanimity of opinion (amongst those best qualified to judge) as to the destructive effects of a heat of 212° F. upon any *Bacteria* or *Bacteria* germs which such fluids may contain.

Taking such a fluid, therefore, in the form of a strong filtered infusion of turnip, we may place it after ebullition in a superheated flask with the assurance that it contains no living organisms. Having ascertained also by our previous experiments with the boiled saline fluids that there is no danger of infection by *Bacteria* from the atmosphere, we may leave the rather narrow mouth of the flask open, as we did in these experiments. But when this is done, the previously clear turnip infusion invariably becomes turbid in one or two days (the temperature being about 70° F.), owing to the presence of myriads of *Bacteria*.

Thus if we take two similar flasks, one of which contains a boiled "Pasteur's solution," and the other a boiled turnip infusion, and if we place them beneath the same bell-jar, it will be found that the first fluid remains clear and free from *Bacteria* for an indefinite period, whilst the second invariably becomes turbid in one or two days.

What is the explanation of these discordant results? We have a right to infer that all pre-existing life has been destroyed in each of the fluids; we have proved also that such fluids are not usually infected by *Bacteria* derived from the air—in this very case, in fact, the putrescible saline fluid remains pure, although the organic infusion standing by its side rapidly putrifies. We can only infer, therefore, that whilst the boiled saline solution is quite incapable of engendering *Bacteria*†, such organisms are able to arise *de novo* in the boiled organic infusion.

Although this inference may be legitimately drawn from such experiments as I have referred to, fortunately it is confirmed and strengthened by the labours of many investigators who have worked under the influence of much more stringent conditions, and in which closed vessels of various kinds have been employed.‡

Whilst we may therefore infer (1) that the putrefaction which occurs in many previously boiled fluids when exposed to the air is not due to a contamination by germs derived from the atmosphere, we have also the same right to conclude (2) that in many cases the first organisms which appear in such fluids have arisen *de novo*, rather than by any process of reproduction from pre-existing forms of life.

Admitting, therefore, that *Bacteria* are ferments capable of initiating putrefactive changes, I am a firm believer also in the existence of not-living ferments under the influence of which putrefactive changes may be initiated in certain fluids—changes which are almost invariably accompanied by a new birth of living particles capable of rapidly developing into *Bacteria*.

"On Just Intonation in Music; with a description of a new Instrument for the easy control of all Systems of Tuning other than the ordinary equal Temperament." By R. H. M. Bosanquet.

The object of this communication is to place the improved systems of tuning within the reach of ordinary musicians; for this purpose the theory and practice are reduced to their simplest forms. A notation is described, adapted to use with ordinary written music, by which the notes to be performed are clearly distinguished. The design of a key-board is described, by which any system of tuning, except the ordinary equal temperament, can be controlled, if only the fifths of the system be all equal. The design is on a symmetrical principle, so that all passages and combinations of notes are performed with the same handling, in whatever key they occur. The theory of the construction of scales is then developed, and a diagram is given, from which the charac-

* In the proportion of 10 grains of the former and 3 of the latter to 1 ounce of distilled water.

† The Modes of Origin of Lowest Organisms, 1871, pp. 36, 51.

‡ Thirteenth Report of the Medical Officer of the Privy Council (1871), p. 59.

* How unwarrantable such a conclusion appears to be, I have elsewhere endeavoured to show. See "Beginnings of Life," 1872, vol. i. pp. 326-333, and pp. 372-399.

† See "Beginnings of Life," vol. ii. p. 35, and vol. i. p. 463.

‡ See a recent communication by Prof. Burdon Sanderson, in NATURE January 9.

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teristics of any required system can be ascertained by inspection. An account is then given of the application of such systems to the new key-board, and particularly of a harmonium, which has been constructed, and contains at present the division of the octave into fifty-three equal intervals in a complete form. Rules for tuning are given. Finally, the application of the system of fifty-three to the violin is discussed.

Throughout the work of former labourers in the same field is reviewed; the obligations of the writer are due to Helmholtz, the late General T. Perronet Thompson, F.R.S., and others.

"On the Composition and Origin of the Waters of a Salt Spring in Huel Seton Mine, with a Chemical and Microscopical Examination of certain Rocks in its Vicinity." By J. Arthur Phillips.

After giving some tables, the author proceeds as follows:—A consideration of the various phenomena connected with the occurrence of this and other apparently similar springs, which have at different times been discovered in the district, would seem to lead to the inference that they all have some more or less direct communication with the sea, and that they are either the result of infiltration of sea-water through faults, or are true and independent sources which, before being tapped below the sea-level, had found their way to the ocean through faults or channels.

The following would appear, in the present state of our knowledge, a probable explanation of the origin of the Huel Seton spring. The cross-course is believed to extend through both granite and clay-slate to the sea. From the close contact of its surfaces, the presence of clay, and from other causes, this fault may be supposed not to be uniformly permeable by water, which can only follow a circuitous passage. In this way it penetrates to depths where reactions take place, which, although not entirely in accordance with the results of daily experience in our laboratories, can, after the investigations of M. Daubrée, M. de Sénarmont, and others, be readily understood. By the action of *sea-water* on *silicates of calcium*, *silicates of sodium* and *chloride of calcium* may be produced. The *sulphate of sodium* of the sea-water will be decomposed by this *chloride of calcium*, with the production of *sulphate of calcium* and *chloride of sodium*. The decomposition of clayey matter by *common salt* may produce *chloride of aluminium* and *silicates of sodium*, while the *magnesium* of the chloride of magnesium may be replaced by *calcium*; lastly, a portion of the *potassium* in the sea-water appears to have been replaced by the *lithium* of the granite.

Royal Geographical Society, Jan. 27.—Major-General Sir H. C. Rawlinson, K.C.B., president, in the chair.—"Journey from Bunder Abbas to Meshed, by Seistan," by Sir Frederick Goldsmid. The object of the author's journey was to carry into effect a settlement of the frontiers of Seistan, with which he had been entrusted. He left Bunder Abbas for the interior, with his party, on December 23, 1871, travelling in an E.N.E. direction first towards Bam. Beyond Bam and Azizabad, the country was fertile and well cultivated; this afterwards ceases, and near Fahraj the central desert begins. Beyond this, to the west, is another tract of mountainous country, bounding the fertile district of Seistan. The Hamun Lake was found dry, except pools of water at the mouths of the rivers, and the party crossed its southern part, where the bed was perfectly dry. Its limits are, however, well-marked by belts of reeds. The waters of the Helmund near and in the Delta had been led off by irrigation canals. The area of Seistan Proper was estimated at 947 square miles, and the population at 35,000. Majors St. John and Lovett, R.E, the surveyors attached to the party, had superintended the execution of a new wall-map of Persia, which was exhibited, and which gave quite a new character to the geography of many parts of Persia. The two great central areas of desert (1,500 to 3,000 feet above the sea-level) were clearly shown, and the snowy-ranges running in a north-west and south-east direction, nearly parallel to the Persian Gulf, well defined. One of these ranges rises to a height of more than 17,000 feet.—"On the Comparative Geography and Ethnology of Seistan," by the President. The country physically is dependent entirely on the River Helmund; and it is probable the earliest Aryan colonists drew off the whole of the water for irrigation, for in the earliest Geographical List, that contained in the "Vendidad," the country was called, not from the lake, but from the river. None of the sites of the cities and places named in ancient history could be identified with certainty. Seistan formed the most southerly province of the ancient Aryan country of Iran.

DIARY

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 8.30.—On the Osteology of Hyopotamidæ: Dr. W. Kowalevsky.—Magnetic Survey of Belgium in 1871: G. J. Perry.
ROYAL INSTITUTION, at 3.—Formation of Organic Substances: Dr. Armstrong.
LINNEAN SOCIETY, at 8.—Notes on Aristolochiaceæ: Dr. Masters.
CHEMICAL SOCIETY, at 8.—On Anthrapurpurin: W. H. Perkin.—On the Solidification of Nitrous Oxide: T. Wells.—On Isomerism in the Terpene Family: Dr. C. A. Wright.
SOCIETY OF ANTIQUARIES, at 8.30.—On Donnington Castle: H. Goodwin.

FRIDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 9.—Old Continents: Prof. Ramsay.
GEOLOGISTS' ASSOCIATION, at 7 30.—Annual Meeting.—On the Diprionidæ of the Moffat Shale: Charles Lapworth.
PHILOLOGICAL SOCIETY, at 8.15.
ARCHÆOLOGICAL INSTITUTION, at 4.
OLD CHANGE MICROSCOPICAL SOCIETY, at 5.30.—On the Internal Economy of Insects: T. Rymer Jones.

SATURDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 3.—Comparative Politics: Dr. E. A. Freeman.
ROYAL BOTANIC SOCIETY, at 3.45.

MONDAY, FEBRUARY 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8 30.
LONDON INSTITUTION, at 4.—Physical Geography: Prof. Duncan.

TUESDAY, FEBRUARY 11.

PHOTOGRAPHIC SOCIETY, at 8.—Annual Meeting.—The Achromatisation of an Object Glass: Prof. G. Stokes.

WEDNESDAY, FEBRUARY 12.

LONDON INSTITUTION, at 7.—Fresco and Siliceous Painting: Prof. Barff.
SOCIETY OF ARTS, at 8.
ARCHÆOLOGICAL ASSOCIATION, at 8.

THURSDAY, FEBRUARY 13.

ROYAL SOCIETY, at 8.30.
SOCIETY OF ANTIQUARIES, at 8.30
MATHEMATICAL SOCIETY, at 8.—On Systems of Linear Congruences: Prof. H. J. S. Smith.

BOOKS RECEIVED

ENGLISH.—On a Hæmatozoon inhabiting Human Blood: T. R. Lewis, Calcutta.—A Report of Microscopical and Physiological Researches into the Nature of the Agent or Agents producing Cholera: T. R. Lewis and D. D. Cunningham.—The Useful Plants of India: Col. H. Drury. Second Edit. (W. H. Allen & Co.).—A Handbook of Hygiene: George Wilson (J. A. Churchill).—Chambers' Arithmetical Exercises: J. S. Mackay (W. & R. Chambers).—Standard Algebra (W. & R. Chambers).—Chambers' Elementary Physical Geography: J. Donald (W. & R. Chambers).—Chambers' Scientific Reader (W. & R. Chambers)—Chambers' Electricity: R M. Ferguson (W. & R. Chambers).—Recollections of Canada: Lieut. Cariile, R.A., and Lieut.-Col. Martindale, Quebec (Chapman & Hall, London).

FOREIGN.—Die Kalkschwamme: eine Monographie. 3 vols, Ernest Haeckel (Williams & Norgate)'—Gespinnst Fassern, &c.: Dr. R. Schlesinger (Williams & Norgate).

PAMPHLETS RECEIVED

ENGLISH.—Potential Functions and their Applications in Physical Science: Prof. J. E. Davies.—Symon's Monthly Meteorological Magazine, No. 74, Vol. vii January.—Quarterly Journal of Education, No. 5, January (Groombridge).—Messenger of Mathematics, No. 21, January (Macmillan & Co).

FOREIGN.—Correspondenzblatt des Naturforcher: Riga.—Sulla Corona Sollare: Prof. L. Respighi.

CONTENTS

	PAGE
SEDGWICK By Prof. PHILLIPS, F.R.S	257
PALMIERI'S VESUVIUS. By DAVID FORBES, F.R.S. (*With Illustration.*)	259
OUR BOOK SHELF	261
LETTERS TO THE EDITOR:—	
Dr. Bastian's Experiments.—Dr. J. BURDON SANDERSON, F.R.S.	261
Eyes and no Eyes	261
Meteor at St. Thomas.—Hon. RAWSON RAWSON	262
Brilliant Meteor.—G. ST. CLAIR, F.G.S.	262
The Antinomies of Kant.—Dr. C. M. INGLEBY	262
The Source of the Solar Heat—MAXWELL HALL	262
The Twinkling of the Stars.—THOS. HAWKSLEY	262
Meteorological Cycles	262
ON THE OLD AND NEW LABORATORIES AT THE ROYAL INSTITUTION, II. By W. SPOTTISWOODE, Treas R S.	263
THE GROWTH AND MIGRATIONS OF HELMINTHS. By M. CORNU	265
A PRIVATE CIRCUMNAVIGATING EXPEDITION	266
FOSSIL CRYPTOGRAMS. By Prof. MCNAB	267
NOTES	267
ON THE COAL QUESTION. By Sir W. ARMSTRONG, C B.	270
RADIANT HEAT. By Capt. J. ERICSSON (*With Illustration.*)	273
SCIENTIFIC SERIALS	274
SOCIETIES AND ACADEMIES	275
BOOKS AND PAMPHLETS RECEIVED	276
DIARY	276

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